The fate of metals in the environment - mechanisms enlightened by 2D and 3D spectromicroscopy

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The fate of contaminants such as heavy metals and both organic and inorganic sorbents in heterogeneous environmental systems such as soils or biofilms is often controlled by (redox-) reactions, mineral precipitation / dissolution / transformation processes, or by the sorption to surface functional groups. Analysis on the bulk scale often hide intermediate products of the above-mentioned processes, as they appear at low concentrations only. In chemical micro- and submicro-niches, however, the concentrations might be significantly higher. To better understand such systems, analysis approaches with high spatial resolution, in combination with chemical sensitivity, can help to identify mechanisms that control the fate of the above-mentioned compounds.

Synchrotron based scanning transmission X-ray microscopy (STXM) provides analytical capabilities such as speciation and quantitative chemical mapping of soft matter (including fully hydrated environmental samples) at ~20-30 nm spatial resolution. In combination with angle-scan tomography one can derive quantitative 3-dimensional distribution maps that can be analyzed statistically to identify correlations between chemical species. This talk will present several examples of STXM studies in the field of biogeo- and environmental science, such as:

1) microbial Fe-mineral formation and the influence of extracellular polymers
2) the sorption of heavy metals/metalloids to cell-mineral aggregates formed by Fe-oxidizing bacteria
3) the influence of microbial Fe-reduction on the Cd distribution in contaminated soils

Furthermore, this talk will briefly describe the instrumentation and some of the recent developments of STXM including XRF-detection (e.g. for As-detection) and STXM tomography (including hydrated samples), and illustrate its capabilities with recent results obtained at the Advanced Light Source (ALS, Berkeley, USA) and at the Canadian Light Source (CLS, Saskatoon, Canada).

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